White Paper

# Monitoring Broadcast Over IP (SDIoIP):

## The Challenges of SDI and Strategies for Ensuring High-Quality IP Broadcasts

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## 1. INTRODUCTION

Today, the broadcast and streaming media industries need to support higher resolution video, better connectivity of infrastructure, and the growing demand for over-the-top (OTT) streaming, all of which are driving broadcasters to move away from serial digital interface (SDI). The broadcast industry is understandably focusing on the infrastructure of the future based on IP (Internet Protocol).

Broadcasters have invested heavily in baseband technology for many years in their studios and control rooms with expensive equipment such as cameras, monitors, switchers, and mixers. Replacing baseband technology makes business sense now it is imperative to move to 3D, 4K, UHD, and 8K in near future.

Ideally, broadcasters must consider changing everything to an IP-based infrastructure, which not only provides the greatest benefits in terms of cost efficiencies and workflow transformation but also supports remote production. The only challenge with this approach is to consider how to utilize the existing SDI equipment that they have in place, and in some cases SDI networks as well. It is important to manage the transition from an all-baseband to an all-IP world, in an incremental manner.

## 2. CHALLENGES WITH SDI NETWORKS

- **Managing increase in bitrates and data**

  With the rapid transitions of media from SD to HD, HD to 4K and soon to 8K channels, the size and amount of data that flows per seconds in the broadcaster's headend has increased by a significant amount. SDI cables will not be able to handle it.

- **SDI routers have reached maximum capacity**.

  A traditional 1152x1152 HD-SDI router needs around 40 RU while an 1152x1152 (10GbE) IP switch only requires 10 RU. That clearly means if an organization must expand its SDI network, a lot of space would be required compared with IP. In addition, the organization would need to invest heavily in infrastructure. Hence, an expansion on SDI is no longer a considerable option for broadcasters.

- **IP is the future, not conventional SDI**

  The industry is already seeing an increase in viewers no longer depending only on their TV and STB sets, and instead watching video over the internet. Broadcasters will not be able to support this delivery model unless they adopt IP.

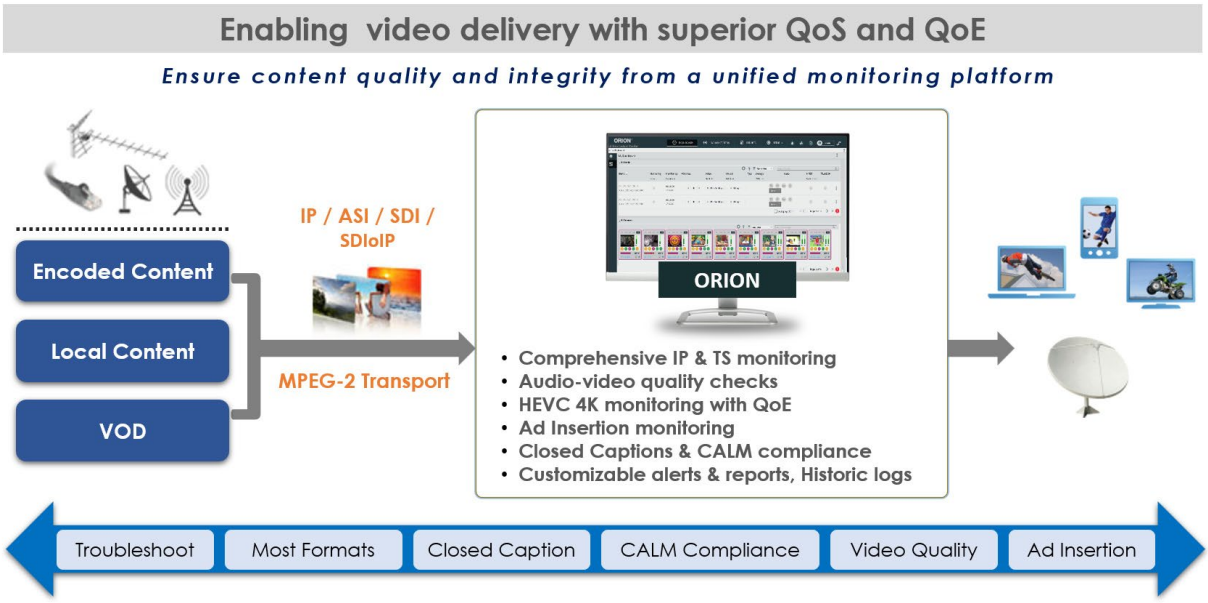
- **Deployments in the cloud and virtual machines**

  In the current scenario, most of the businesses are looking for virtualization and cloud-enabled technologies. The broadcast industry cannot give these technologies a back seat.

  Theoretically it's on everyone's wish list to host operational equipment in the cloud, however depending on the current infrastructure and content, some broadcasters might be using on-premises equipment. Moving everything on cloud is not an easy task. Complete migration may take years in time and a significant amount of planning, with a long overlap while both setups are operating. Big broadcasters cannot switch to the cloud or virtualize everything overnight. The transition to cloud not only takes a lot of time, but the overall migration project will be expensive as well. Breaking even of the investment can take years.

- **Managing the SDI sites and infrastructure remotely**

  During the COVID-19 pandemic, many people worked remotely. Those who were already using IP-based systems could manage the work efficiently. However, those still on conventional SDI networks had a difficult time. Many engineers and operators had to stay in their offices for weeks and months just to ensure smooth operations as remote working was not an option for them. During that time, companies reckoned that they must be remote-ready to be sustainable. Many conventional channels have been forced to move their operations to the cloud during the COVID-19 crisis to ensure their channels do not go offline.




## 3. BENEFITS OF IP NETWORKS OVER SDI

The infrastructure that earlier generations of broadcasters dealt with was SDI baseband. IP-based broadcasting came into picture about two decades ago. Those who were early adopters of IP bid on the right horse. Apart from a few big names in the industry, most broadcasters even now are not 100% IP based. They still have a mix of SDI and IP networks. Everyone in the industry now believes that conventional SDI will die out soon and would be taken over by IP.

The biggest challenge that early adopters of IP faced was the lack of common specs. Whatever broadcasters had previously used in their headend needed to stay operational, and the IP streams that they produced were not interoperable. Those who implemented IP against conventional SDI did so based on this understanding.

However, given the popularity and eagerness of the broadcasters to move to IP, SMPTE recently started defining standards that allow true interoperability and efficiency, such as **SMPTE ST 2110, 2022-6**. This standard makes the switch from SDI to IP a feasible option for migration. Since the specs are out now, SDIoIP is by default the choice for all future expansions and refresh projects. With this in place, broadcasters can be relieved of some of the older issues like:

- With the IP network, one does not have to deal with a bunch of cables. A single 10 Gb port can carry around six HD-SDI channels, assuming each one is 1500 Mbps. In terms of cables, the number gets reduced down to one-sixth. IP cables are bidirectional, which is a benefit, as a single port on a traditional HD-SDI router can only carry one input or output.
- IP infrastructure takes up less space compared with SDI. For comparison purposes, with IP a switch of the same capacity can be deployed in one-fourth of the space as an SDI switch would take.
- IP switches and routers offer commercial-off-the-shelf (COTS) pricing and are very easy to manage remotely and locally.
- IP switches are cheaper and hence the cost benefit is higher.
- Expansions and management is easy with IP. IP can be migrated or deployed to the cloud and virtual environments very easily. With SDI baseband, this is not possible.
- IP-based networks allow broadcasters to run software on generic IT servers rather than vendors badged systems.
- IP networks provide the flexibility to move to a software as a service (SaaS) model easily, enabling broadcasters to simply pay for what they use and saves costs.

With these standards in place, broadcasters no longer face all of the problems of conventional SDI as mentioned above; however, the migration to this standard comes with its own level of implementation complexity and new challenges. Monitoring SDIoIP is one among one of the top challenges.

## 4. MONITORING BROADCAST OVER IP

In general, content monitoring is crucial to ensure better quality of service (QoS) and quality of experience (QoE). SDI over IP streams are received at the initial stage of the video processing chain. The streams need to be monitored for the presence of stream as well as for errors and video quality issues.

Let's examine the high-level specification of the ST 2110 standard before we get into the monitoring aspect.

### 4.1 UNDERSTANDING BROADCAST OVER IP STANDARADS

At a high level, the **ST 2110** standard for uncompressed video, which is a preferred method over ST 2022-6 (compressed), specifies to break audio, video and ancillary data in multiple streams and route them separately over UDP via sample link. In comparison, the **ST 2022-6 standard,** takes the entire SDI signal and encapsulates it in IP streams. It basically packetizes every single bit of data from the coaxial cable (SDI) and makes it available in the IP network as a series of packets.

With 2110, the process of adding metadata like closed captions, teletext, and TCs, processing multiple languages get further simplified. Different types of data such as audio, video, and closed captions are received separately but combined into one stream at the appropriate stage in video processing. The specification ensures that all components (i.e., audio, video, ANC data) are in sync while remaining independent streams. The following describes various specs and their primary function.

- **Media transport over IP (2110-10/20/30/40)**
    - **SMPTE ST 2110-10:** Addresses system concerns and uncompressed video and audio streams. 2110-10 outlines the systems level and timing.
    - **SMPTE ST 2110-20:** Focuses on uncompressed video encapsulations.
    - **SMPTE ST 2110-30:** Defines rules for handling uncompressed audio.
    - **SMPTE ST 2110-40:** To map ancillary data packets (as defined in SMPTE ST 291-1) into Real-Time Transport Protocol (RTP) packets that are transported via User Data Protocol/Internet Protocol (UDP/IP) and enables those packets to be moved synchronously with associated video and audio essence streams.
- **2110-21:** Defines how to put packets out on the network in a controlled manner. Ensures there is no over or under buffer flow.
- **2110-31:** Specifies the real-time, RTP-based transport of AES3 signals over IP networks, referenced to a network reference clock.
- **2110-22/23:** 2110-23 mentions how to do large format videos over multiple sub streams, making it easier for networks to handle. 2110-22 defines how to compress constant bitrate over IP networks that are compatible with 2110.

- **2022-7 redundant Transport:** Specs 2110 states delivery of streams over UDP, which does not have a mechanism to resend the packets if any are lost. Though 2110 is an architecture in that packets are not lost. In the worst case scenarios, if some data is lost, there is no way to recover it. This is the area where 2022-7 outlines redundancy and ensures the data is recovered at the receiver's end.
- **PTP-Timing and Synchronization:** Precision time protocol that is called out specifically in 2110 and that defines how timing works. PTP is needed to support 2110 base systems.
- **JT-NM TR-1001 / NMOS**

### 4.2 WHAT AND HOW TO MONITOR SDI OVER IP (ST-2110)

Based on the understanding of the specs, we can see how important it is to monitor the streams through an automated software solution, rather than just relying on conventional ways of manual monitoring by looking at the decoded outputs.

Here are some of the key parameters that must be checked and monitored in SDIoIP streams.

- Unavailability errors at service, video, audio, and ANC levels
- Monitoring both primary and secondary streams simultaneously
    - Check for frame sync across both
    - Always ensure other data is synchronized across both
- Since this spec does not have a mechanism like Continuity Counters in TS, monitoring the packet loss by alternative means involves:
    - comparing the primary and secondary feeds
    - bitrate monitoring
    - monitoring decoding issues caused because of packet losses
- PTP timing and clock analysis

Apart from the parameters, monitoring audio and video quality is also important to ensure the audio and video streams are free from unwanted blacks, freezes, silences, and video glitches. Only with comprehensive monitoring, you can ensure error-free, interoperable streams and content.

Key capabilities to look for in monitoring tools include:

- Sends alerts in real time in different forms like emails, SNMP, and audio alerts
- Offers configurable alert thresholds and support for multi-severity
- Have ability to save erroneous portions of streams for offline analysis
- Ability to save historical reports for analysis, as required
- Easy to integrate with other NMS and third-party solutions in place

## 5. INTERRA SYSTEMS' ORION FOR MONITORING OF SDIOIP

Interra Systems' ORION® is designed keeping the diverse complexities and challenges of the SDI and IP environments in mind, providing an edge as the only enterprise-class software solution that offers a simple, yet powerful approach to content monitoring for IP, ASI, SDI and SDIoIP standards such as ST 2110. ORION performs critical monitoring functions in a single, integrated platform that is comprehensive, efficient, and easily scalable for hundreds of programs.

ORION effortlessly monitors streaming content, scaling single to multiple monitoring units and sites across different geographical locations. ORION has a rich and customizable web-based interface that enables remote monitoring and provides extreme flexibility and on-the-go decision-making. In addition, ORION offers important features like error detection, video quality analysis, alerts, reporting, thumbnails, and trend analysis. It monitors the streams for both QoS and QoE, providing a comprehensive report of the errors as and when detected via email, SNMP, and audio alerts. It's very easy to configure and use. All of the monitoring info is saved for a long duration and the UI simplifies analysis of historic reports. It is not only integrated with most of the common network management systems and third-party solutions, but also offers rich set of REST APIs that can be used to ensure seamless integration with any new software or platform.

## 6. CONCLUSION

IP is clearly the future, and it cannot be overlooked. As broadcasters shift to IP from conventional broadcasting, new monitoring devices and software need to be deployed accordingly. It is impossible to rely on conventional, manual-based ways of monitoring

video channels. The streams must not only meet the quality standards for audio and visual issues, but also comply with industry specifications.